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Remarks

Claims 1-16, 28-30, and 32-34 are pending in this application. Reconsideration and allowance are respectfully requested.

The Examiner issued a restriction requirement, and Applicants representative verbally elected to prosecute Group 1, claims 1-16 and 27, drawn to a composition. This verbal election is confirmed here without traverse, and claims 17-26 are cancelled. Claim 27 is also cancelled.

Substance of the Interview

The undersigned Applicant's representative (hereafter "Applicant") had an in-person interview with the Examiner regarding this case on January 26, 2006. Applicant first brought to the Examiner's attention the error in the prior amendment concerning the claim to common ownership of the Small reference. The Examiner and Applicant agreed there was no issue as the Examiner had merely reverted to the parent application of the previously cited application, the disclosure of which was identical to that of the previously cited Small reference, in maintaining the prior rejections. The undersigned then discussed each of the 112 rejections, with particular emphasis that the term "comprising" is not equivalent to the term "is." Applicant explained that boron is a non-metallic element, showing evidence thereof. For both of these issues, the Examiner pointed out that the pending application is misleading in places, and the Examiner requested particular paragraphs be corrected by amending the specification. Applicant further pointed out the support for the stabilizer comprising phosphorous, and the Examiner agreed to review those claims pertaining to phosphorous. Finally, with respect to the claim 12 issue that a stabilizer being placed onto the abrasive before or simultaneously with a catalyst results in a different structure than if the stabilizer is added after the catalyst, the Applicant and the Examiner reviewed the data (from the Examples) which showed the results arising from the different structure. The Examiner requested that this argument be reproduced in this amendment at the earliest opportunity. Applicant and Examiner then reviewed each of the prior art rejections in detail, including reasons why Applicant believes each rejection is overcome.

Revocation of Statement of Common Ownership

In the prior Response dated October 28, 2005, Applicants stated that the present invention and the subject matter of Small et al. contained in Published application 2004/0029495

(as well as published applications 2003/0162398 and 2004/0006924 having similar subject matter and also having as inventor Small et all) were commonly owned at the time the present invention was made. Applicants hereby rescind that statement. The error was made by mistake and with no intent to deceive. Section 103c excludes art that is wholly owned by the same entity at the time the invention was made. In the instant case, the invention on the date this pending application was filed was subject to assignment to the same entity which owns by virtue of a recorded assignment all rights to Published application 2004/0029495. Subsequent careful review of records suggests, however, that the inventor actually conceived and may have reduced to practice at least some embodiments of the claimed invention during a period of time when the previous assignee of Published application 2004/0029495 and the assignee of the instant application were in negotiations to merge the ownership of the intellectual property, but before the merger in fact occurred.

Fortunately, the Examiner in the instant action repeated the previous rejections using Small'398 instead of Small'495, as Small'398 is not able to be disqualified by a statement of common ownership. Small'495 is a continuation of Small'398, and therefore has the identical disclosure as Small'398. As a result, the Examiner was not unduly prejudiced by Applicant's mistake.

Current Rejections under 35 USC 112, first paragraph.

Claims 1-3, 12-16, and 27-34 stand rejected under 35 USC 112, first paragraph.

With respect to claims 1, 28, 29, and 31:

The Examiner states that the limitation "stabilizer comprising ... P" is new matter because the specification never literally defines or suggests that the stabilizer is "P". The Examiner opined that the support cited by Applicant, in particular paragraph [0035], is not sufficient because 1) the paragraph is not clearly referring to stabilizer and because 2) paragraph [0033] defines that the stabilizer is a metal. With respect to claim 1, applicants have amended this claim to remove the contested element "P." Claim 31 is cancelled.

However, to preserve the issue, Applicant amended each of claims 28 and 29 to be in independent form (and with the Examiner's express permission deleting extraneous phrases from

the independent claims 28 and 29 that are not applicable when the stabilizer is only claimed to comprise phosphorus), and with respect to those claims Applicant traverses.

First, regarding the Examiner's contention that paragraph [0033] defines stabilizers as metals, the Examiner is mischaracterizing the disclosure. The pertinent sentence reads "Suitable stabilizers include metals and borderline metals, such as, e.g., boron, aluminum and titanium, with boron being most preferred." (Underlining added). Saying that "stabilizers include metals and borderline metals" does not define the stabilizer as a metal, especially when the preferred stabilizer does not in fact include a metal. The most preferred stabilizer includes boron. Boron is defined in Hawley's Condensed Chemical Dictionary, Twelfth Edition, as a "nonmetallic element of atomic number 5." The American Heritage College Dictionary, Fourth edition, defines boron as a "soft, amorphous or crystalline nonmetallic element." Copies of the covers of these dictionaries and of the pertinent pages 163 and 167, respectively, are attached hereto for the Examiner's convenience. Contrary to the Examiner's characterization, the specification clearly does not define and limit stabilizers to metals.

Regarding the Examiner's contention that paragraph [0035] does not "literally define" that the phosphorus is a stabilizer, Applicants also traverse. The Examiner is directed first to MPEP 2163-2163.07(b) which states in part:

"The description requirement is simply that the claimed subject matter must be described in the specification. The function of the description requirement is to ensure that the applicant had in his possession, as of the filing date of the application relied on, the specific subject matter later claimed by him. . . . It is not necessary that the application describe the claim limitations exactly, but only so clearly that persons of ordinary skill in the art would recognize from the disclosure that applicant's invention included those limitations. . . ."

The Examiner is also directed specifically to MPEP 2163.04, which states in part:

"The examiner has the initial burden of presenting evidence or reasons why persons skilled in the art would not recognize in an applicant's disclosure a description of the invention defined by the claims. . . . The PTO has done nothing more than to argue lack of literal support, which is not enough" to support a rejection under 35 U.S.C. 112, first paragraph."

The P.T.O.'s own revised interim guidelines concerning compliance with the written description requirement provide that the disclosure of identifying characteristics such as partial

structure, functional characteristics and method of making must all be weighed in view of the level of skill and the knowledge in the art and in the light and consistent with the written description. See 66 Fed. Reg. 1099 (2001). A review of the application as a whole supports the claim that the stabilizer can be a compound that comprises phosphorus.

Paragraph [0025] states “the invention eliminates the need for adding soluble metal catalysts to catalyze oxidation by hydrogen peroxide.” Paragraph [0026] states “the compositions of the invention comprise a surface-modified abrasive modified with at least one stabilizer and at least catalyst.” (Paragraphs [0027] to [0032] describe characteristics of the abrasive, and are not pertinent to this discussion). Paragraph [0033] discusses stabilizers, stating (as discussed above) that stabilizers include metals and “borderline metals”, but includes specifically and preferably nonmetallic boron. Paragraph [0034] discusses catalysts, listing specifically Cu, Fe, Mn, Ti, W, and V, and states iron is the preferred catalyst. Unlike the stabilizers, the listed catalysts are all metals.

Now paragraph [0035] describes the invention as “a bimetallic surface-modified colloidal abrasive containing as the two metals on the surface of the abrasive”, and also describes the invention as abrasives with surfaces modified with “combinations of metals and non-metals.” Specific examples given in paragraph [0035] include “boron and iron; boron and copper; or iron and tungsten.” As one of ordinary skill in the art would clearly know, “iron and tungsten” is a mixture of two metals, while “boron and iron” and “boron and copper” are in fact “combinations of metals and non-metals.” There is no hint that the catalyst can be anything but a compound comprising metal, while the stabilizer can be a compound comprising metal or a nonmetal, as one of ordinary skill in the art would understand from the teaching of compounds containing nonmetallic boron are the most preferred embodiment. Paragraph [0035] ends with the following sentence: “Phosphorus is a particularly preferred non-metal suitable for use in mixed metal/non-metal surface-modified abrasives of the invention.” The Examiner contends that this would not teach one of ordinary skill in the art that the compound including phosphorous is a stabilizer. Applicant respectfully requests that the Examiner reconsider this conclusion in view of the teaching of the application as a whole, in particular in view of paragraphs [0025] to [0035] summarized above.

The Examiner also states the limitation “mixture thereof” is new matter because the specification does not suggest that mixtures of the claimed stabilizers can be used. This rejection is believed moot after the amendment to claim 1.

With respect to claims 12:

The Examiner objects to the limitation “differs both from the catalyst and from the abrasive particle” as new matter because the specification never literally defines that the stabilizer differs from the abrasive particle. Applicants have deleted the offending language, as this limitation is inherent in the word “stabilizer.” Paragraph [0011] states “the invention provides a surface-modified abrasive modified with at least one stabilizer and at least one catalyst differing from the at least one stabilizer.” Paragraph [0033] states “the term “stabilizer” means an agent effective to help maintain the abrasive as a sol in an aqueous medium.” If the stabilizer was the same as the abrasive particle, it would neither modify the surface of the abrasive nor help maintain the abrasive as a sol in an aqueous medium.

With respect to claims 13, 16, and 30:

The Examiner rejects claims 13, 16, and 30 as they each recite the stabilizer can be tungstate, stating “the stabilizer in the specification is only limited to W (i.e., specific element and not a tungstate.” Applicants TRAVERSE WITH AS MUCH EMPHASIS AS IS POSSIBLE TO EXPRESS.

First, there is specific support for tungstate, as paragraph [0076] in the filed specification states Example 7 is “SYTON HT 50 (*silica*) with modified Fe-tungstate bimetallic surface.”

Second, to say that a stabilizer comprises an element (B, W, Al, or even P) does not mean the stabilizer is that element. Originally filed paragraph [0014] states “the at least one stabilizer **comprises** at least one member selected from the group consisting of B, W and Al.” (Emphasis added). The Examiner is apparently construing the term “comprises” to mean “is.” The Examiner is directed to MPEP 2111.03, which states in part: “the transitional term comprising, which is synonymous with “including”, “containing”, or “characterized by”, is inclusive or open-ended and does not exclude additional unrecited elements.” As one skilled in the art would appreciate, the stabilizer can not be “B” because elemental B is very reactive and can not exist (for any appreciable amount of time) contacting water. The preferred stabilizer is not B but is

boric acid. The same for Al – metallic Al is very reactive and can not exist (for any appreciable amount of time) contacting water. It also would be instantly converted to an oxide or hydroxide.

Finally, and back to the specific issue raised by the Examiner, to say the stabilizer comprises W is not to say the stabilizer is W! The specification is not teaching that the stabilizer is W. W is a metal, and a metal will not work as a stabilizer. Applicants concede that the specification often refers to the critical element within the stabilizer as the stabilizer itself. While the specification characterizes the modifier as the metal or B, what is meant is the compound which comprises the metal or B. See for example the excerpts from paragraphs which are all discussing the experiment described in detail in paragraph [0068] where silica was sequentially modified with ferric nitrate and with sodium tungstate as follows:

[0068] Deionized SYTON HT 50 was prepared in accordance with Example 1. 10.1 grams of **ferric nitrate** were added to the deionized SYTON HT 50 (600 grams, pH=1.9 to 2.1). ... In a separate beaker, 300 grams of deionized water were charged, and kept under agitation. To this water solution, **sodium tungstate** (10.9 grams) was added under agitation during a period of 10 minutes. ... The **tungstate solution** was then added to the **iron-modified silica** particles, and stirred for an additional 2 hours. ...

Paragraph [0069] uses the elements when it states “the polishing composition in Example 7 was prepared using “**iron-tungsten**” **modified silica** and the preparation method of Example 4.” The “**SYTON HT 50 with modified Fe-tungstate bimetallic surface**” described in the table in paragraph [0076] is the exact same sample which is described as “ ‘iron-tungsten’ **modified silica**” in paragraph [0069]. As it is clear that the phrases are all describing the same sample, it is obvious that the Applicant often refers to the catalyst and to the stabilizer only by the critical element contained therein.

Applicant notes the same use of the terminology holds true for boron. Paragraph [0061] in the filed specification clearly describes how the silica in example 2 was modified by boric acid, and then states “The resulting solution was subsequently filtered through a 1-micron filter to afford **boron surface-modified colloidal silica**.” This should not be construed that the surface is modified by elemental boron! Paragraph [0069] (in describing this same sample after it had been additionally treated with ferric nitrate) states “the polishing composition in Example 6 was prepared using bimetallic “**boron-iron**” **modified silica** and the preparation method of Example 2.”

For the rejection of claims 13, 16, and 30 specifically, Applicants specifically traverse because tungstate is supported. Example 4 in paragraph [0068] of the filed application teaches a method where “The tungstate solution was then added to the iron-modified silica particles, and stirred for an additional 2 hours” to provide the abrasive used in Example 7. Paragraph [0076] in the filed specification states Example 7 is “SYTON HT 50 (*silica*) with modified Fe-tungstate bimetallic surface.” In view of these arguments, Applicant respectfully requests that the Examiner reconsider this rejection.

With respect to claim 32:

The Examiner rejects claim 32 as it recites “borate”, which the Examiner contends is not disclosed in the specification. Applicant agrees the word “borate” is not specifically used in the specification, even though a stabilizer which comprises B in the form of boric acid will obviously comprise borate. The rejection should nevertheless be withdrawn because in fact claim 32 also does not recite borate but recites “the at least one stabilizer comprises B in the form of boric acid.” Applicant has confirmed that the word “borate” is not present in the claims by checking the claims as published on the PAIR system.

With respect to claim 33:

The Examiner rejects claim 33 stating the limitation “wherein the abrasive particles have a positive zeta potential” is not defined in the specification because the zeta potential of the abrasive particles is different than the zeta potential of the surface-modified abrasive particles. As agreed during the interview, claim 33 is amended to resolve the Examiner’s uncertainty by more fully reciting the material described in Claim 12, i.e., “an abrasive particle having a surface on which are bonded at least one stabilizer and at least one catalyst.”

With respect to claim 34:

Claim 34 stands rejected as it recites an “Al containing stabilizer.” The Examiner is directed to the above discussion concerning claims 13, 16, and 30 regarding tungstate, where the arguments made there are incorporated here by reference. The specification at paragraph [0014] states “the at least one stabilizer comprises at least one member selected from the group consisting of B, W and Al.” This sentence is properly construed as saying the stabilizer includes

B, W, or Al. Boric acid is a stabilizer that comprises B. Tungstate is a stabilizer that comprises B. The specific stabilizer compound which includes Al was not mentioned in the specification, so applicants are forced to use the above language.

As discussed extensively herein, such a form of writing occurs throughout the specification. Look for example at the description of a catalyst. The specification at paragraph [0014] states “the at least one catalyst comprises at least one member selected from the group consisting of Cu, Fe, Mn, Ti, W and V.” This should not be construed to mean for example metallic metal is required. The specification at paragraph [0034] teaches “preferred catalysts possess multiple oxidation states.” Metal has only one oxidation state, which is zero. The preferred catalyst “comprises Fe”, but paragraphs 64, 65, 66, 67, and 68 show the silica is in fact modified with ferric nitrate.

For yet another example of this style of disclosure, look also for example at the description of the substrate. Original paragraph [0020] states “the substrate comprises at least one member selected from the group consisting of W, Ti, Cu, Ta, Si, Ga, As, C and N, more preferably from the group consisting of W, Ti, TiN, Ta, TaN, Cu and SiO₂. The disclosure that “the substrate comprises at least one member selected from … Si” must be construed as the substrate includes Si, not that the substrate is Si. Otherwise, the substrate could not encompass the preferred SiO₂.

Current Rejections under 35 USC 112, second paragraph.

The Examiner has rejected claims 12-16, 27, 31, 32, and 34 under 35 USC 112, second paragraph. Applicants traverse.

With respect to claim 12:

Claim 12 stands rejected as the Examiner opines the last two lines are wordy and therefore are not clear and concise. This last limitation reads “wherein the stabilizer is bonded to the abrasive prior to or simultaneously with the bonding the catalyst to the abrasive.” Applicant can see no way of shortening this. The specification at paragraph [0056] states “A preferred method for synthesizing a bimetallic surface-modified colloidal abrasive particle of the invention comprises the following two-step process. The first step provides a boron or tungsten modified surface-modified colloidal abrasive particle, as discussed above, and the second step adds a

second metal (e.g., iron, copper or tungsten) to the surface of the boron or tungsten modified surface-modified colloidal abrasive particle."

During the Interview, the Examiner requested that we mention at this point that the product manufactured by the above process in fact makes a different product that would result if the catalyst is put onto the abrasive before the stabilizer is added. Applicants found out, and it is amply shown by the data in the Examples, that faster polishing rates are attained if the stabilizer is added to the abrasive first, and then the catalyst is added second. Intermediate results are obtained if the stabilizer and the catalyst are added to the abrasive at the same time. Poor polishing rates are seen if the catalyst is added to the abrasive particle first, and then the stabilizer is added second. As stated in the previous amendment, the criticality of the order of addition of stabilizer and catalyst are shown in the Examples.

Example	Example 7 (not covered by claim 12)	Example 6	Example 9
Order of addition of stabilizer and catalyst onto silica	catalyst first, and then the stabilizer second	stabilizer and catalyst were added at the same time	stabilizer first, and then the catalyst second
Amount of Fe catalyst	10.1 grams ferric nitrate per 600 grams silica	10.1 grams ferric nitrate per 600 grams silica	3.06 grams ferric nitrate per 600 grams silica
Polishing rate (A/min)	2655	3880	2751

The superiority of having catalyst and stabilizer added at the same time is clearly shown by comparison of Examples 7 and 6. Indeed, the best results are obtained when stabilizer is added first and the catalyst is added second. The polishing rate of Example 9 (having only 30% as much catalyst as was present in Example 7) was nevertheless higher than the polishing rate of Example 7. This is clear evidence that the order of addition of stabilizer and catalyst onto the

abrasive made a large difference in polishing rates of the resultant product, and therefore results in a different product.

The Examiner states that “process limitations used to define a product in a product by process claims do not patentably distinguish the product even though made by a different process.” Applicants disagree, as it is clear here that the product made by this process results in a different product than is otherwise made. The specification and the examples clearly show the product made by bonding the stabilizer first and the catalyst second is not equivalent to the product made by bonding the catalyst first and the stabilizer second. There are numerous reasons. If stabilizer is bound second, a portion of the catalyst will be obscured by the stabilizer. But more importantly, Applicant believes the catalyst is made more effective because the catalyst actually bonds not to the abrasive but to the stabilizer itself. (This is clear from the examples, where substantially all available sights were coated by stabilizing boric acid, and then the catalyst was added.) This added efficacy of catalyst-bonded-to-stabilizer compared to catalyst-bonded-to-silica makes thermodynamic sense, because a boron-Fe bond is shorter than a Silica-Fe bond and therefore has higher energy. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 12.

With respect to claim 27:

The Examiner rejects original claim 27 having the phrase “is substantially free of soluble metal catalysts” because the Examiner is unclear as to what this encompasses. This claim has been cancelled.

With respect to claim 32:

The Examiner rejects claim 32 as reciting “the borate.” The absence of this word has been discussed above.

With respect to claim 34:

The Examiner rejects claim 34 as reciting “the Al-containing stabilizer” because this lacks antecedent basis. Specifically, the Examiner states that the phrase “the at least one stabilizer comprises Al” does not provide antecedent basis for “the Al-containing stabilizer.” The Examiner is directed to MPEP 2111.03, which states in part:

“the transitional term comprising, which is synonymous with “including”, “containing”, or “characterized by”, is inclusive or open-ended and does not exclude additional unrecited elements.”

Using the MPEP’s own synonym, Applicant contends a “stabilizer comprising ... Al” is properly construed to be “a stabilizer containing Al” which clearly provides antecedent basis for “the Al-containing stabilizer.”

Current Rejections under 35 USC 103.

Rejection over Small '398

The Examiner has rejected claims 1-15, 27, 32, 33, and 34 as obvious over Small '398 (2003/0162398). Applicants respectfully traverse.

With respect to independent claim 1 and dependent claims 2-11:

Claim 1 recites “an abrasive particle having a surface on which at least one stabilizer comprising B, Al, or mixtures thereof and at least one catalyst are bonded.” Small '398 nowhere discloses an abrasive having a stabilizer comprising aluminum nor boron bonded to the surface thereof. The Examiner is apparently contending that because Small '398 teaches one or more catalysts can be on a surface of a particle coupled with the phrase in Small'398 that the “catalyst comprises a metal other than a metal of Group 4(b), Group 5(b) or Group 6(b) of the Periodic Table of Elements” anticipates the instant claims. This reasoning is wrong for two reasons. Merely reciting what a catalyst is a metal excluding a few selected metals not does not anticipate a claim to a stabilizer. Small'398 teaches at paragraph [0010] that “metals of Group 1(b) or Group 8 are suitable candidates, as are metals having a standard oxidation of from about -0.52 to about -0.25 eV.” Neither B nor Al falls into either of these categories. Small'398 also teaches at paragraph [0029] that “suitable metal includes, but is not limited to cobalt, copper, iron, nickel, silver, and any combination thereof.” Neither B nor Al qualifies. The term “catalyst” implies the material increases some reaction rate, and indeed Small'398 at paragraph [0012] states “catalyst-coated abrasive is particularly effective as it ... facilitates or accelerates the removal reaction substantially at the site of the targeted material.” Neither B nor Al is believed to qualify here, as neither is believed to accelerate polishing rates. See for example the very low polishing rate by silica coated with boric acid, example 5 in the instant specification at paragraph [0076].

As clearly stated in the instant specification, the stabilizer promotes stability of the sol. The Examiner states “a reference is good not only for what it teaches but also for what one of ordinary skill in the art might reasonably infer from the teaching. One of ordinary skill in the art, if he were tempted to test EVERY metal in existence other than a metal of Group 4(b), Group 5(b) or Group 6(b) of the Periodic Table of Elements, would eventually get around to testing aluminum and would discover that like almost every other metal he tested that aluminum does not act as a catalyst. Said one of ordinary skill in the art, if he were tempted to test EVERY metal in existence other than a metal of Group 4(b), Group 5(b) or Group 6(b) of the Periodic Table of Elements, would never get around to testing B. Applicant therefore does not understand why a disclosure reciting two catalysts, where the catalysts are described as metals having various characteristics, would make obvious a particle having a stabilizer and a catalyst as recited in claim 1, where the recited stabilizers in claim 1 are not catalysts and do not have any characteristics described in Small'398 of a catalyst. Applicants respectfully request the Examiner reconsider this rejection.

With respect to independent claim 12 and dependent claims 13-15 and 32-34

Claims 12-15 and 32-34 not only recite that the particle comprise a stabilizer and a catalyst, but also that the stabilizer is bonded to the abrasive prior to or simultaneously with the bonding the catalyst to the abrasive. No stabilizer is taught nor disclosed in Small'398, and Small'398 does not disclose any preference or order of bonding even catalysts to an abrasive. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 12.

With further respect to dependent claims 13, 32, and 34

Claims 13, 32 and 34 further recite that the stabilizer be bonded to the abrasive before bonding the catalyst. This is clearly in no way taught nor suggested in any way in Small'398. Applicants respectfully request the Examiner reconsider this rejection with respect to claims 13, 32, and 34.

With further respect to dependent claims 4, 6-10, 13-15, and 32-33

Claim 4, 6-10, 13-15, and 32-33 recites the stabilizer comprises B. Boron is non-metallic. Small '398 nowhere suggests the catalyst can be boron, and nowhere suggests the

catalyst can be a non-metal. Applicants respectfully request the Examiner reconsider this rejection.

Rejection over Grunwald '710 in view of Small '398

The Examiner has rejected claims 12, 13, 16, and 30 as obvious over Grunwald'710 in view of Small '398 (2003/0162398). Applicant traverses. The Examiner contends Grunwald teaches a composition in which an abrasive is coated with the claimed metals, and while the stabilizers are not defined as such no distinction is seen to exist.

With respect to independent claim 12 and dependent claims 13, 16, and 30

Claim 12 not only recites that the particle comprise a stabilizer and a catalyst, but also that the stabilizer is bonded to the abrasive prior to or simultaneously with the bonding the catalyst to the abrasive. Grunwald'710 in column 2 at lines 13-18 indeed teaches a stabilizer, that is, a coating that provides enhanced dispersability. Grunwald'710 in column 2 at lines 64-67 suggests a stabilizer can be a metal oxide. Small'398 teaches mixtures of catalysts. Some of Small'398's listed catalysts, in particular Fe and Cu, are listed in Grunwald'710 as useful coatings. But neither reference alone or in combination discloses any preference or order of bonding a stabilizer and a catalyst layer. Claim 12 recites such a preference. Further, as discussed extensively in the sections above, the order of addition of stabilizer and catalyst to the abrasive makes a patentably distinct product with greatly differing polishing characteristics. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 12.

With further respect to dependent claim 13

Claim 13 further recites that the stabilizer be bonded to the abrasive before bonding the catalyst. This is clearly in no way taught nor suggested in any way in Grunwald'710 nor in Small '398, alone or in combination. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 13.

With further respect to dependent claims 13, 16, and 30

Claims 13, 16, and 30 recite that the stabilizer comprises tungstate. Neither tungsten nor tungstate is described as a suitable coating for a particle in either Grunwald'710 or Small '398.

The Examiner concedes that Grunwald nowhere suggests the stabilizer can comprise tungsten, but the Examiner is opining (with no supporting evidence) that the disclosure of “Wo” in Grunwald’710 teaches tungsten. Small’398 expressly excludes metals of Group 4(b), Group 5(b) and Group 6(b) of the Periodic Table of Elements, and tungsten falls within the expressly excluded metals of Small’398. Nevertheless, despite neither reference teaching a coating of tungsten, and despite Small’398 expressly teaching away from tungsten, the Examiner opines that an abrasive comprising a catalyst and a stabilizer comprising tungsten coated thereon is obvious over the combination of these references!

Then, with NO supporting evidence of any kind, the Examiner opines that:

“although tungstate is not defined (in the references), the reference defines that a metal bearing layer (i.e., defined as a water insoluble metal compound – column 3, lines 36-40) and it is the Examiner position that one skilled in the art would have appreciated that tungsten compounds can be used to deposit the metal bearing layer because tungstate compounds broadly fall within the teaching of “metal bearing layer” (i.e., insoluble metal compound) of the reference.”

The Examiner appears to be saying that tungstate would be obvious because it is an insoluble metal compound and the references call for an insoluble metal compound. The Examiners attention is directed to paragraph [0068] of the instant specification which teaches dissolving 10.9 grams of sodium tungstate into less than a liter of water. As the Examiner has not established even a semblance of a proper *prima facie* case for unpatentability, Applicant respectfully requests the Examiner reconsider this rejection with respect to claims 13, 16, and 30.

Rejection over Mueller ’288 in view of Grunwald ’710

The Examiner has rejected claims 12, 13, 16, and 30 as obvious over Mueller’288 in view of Grunwald’710. Applicant traverses with arguments that closely follow those presented in the section regarding the rejection of these same claims over Grunwald ’710 in view of Small ’398.

With respect to independent claim 12 and dependent claims 13, 16, and 30

Claim 12 not only recites that the particle comprise a stabilizer and a catalyst, but also that the stabilizer is bonded to the abrasive prior to or simultaneously with the bonding the catalyst to the abrasive. Grunwald’710 in column 2 at lines 13-18 indeed teaches a stabilizer, that is, a coating that provides enhanced dispersability. Grunwald ’710 in column 2 at lines 64-

67 suggests a stabilizer can be a metal oxide. Mueller'288 teaches mixtures of catalysts, but all of the catalysts taught by Mueller'288 are water-soluble catalysts. Many of Mueller'288 listed water-soluble catalysts, in particular Fe, Cu, Ti, Sn, Mo, and Nb, are listed in Grunwald'710 as useful coatings. But Grunwald's teaching of a stabilizer bound to a particle does not suggest that the soluble catalysts of Mueller'288 can or should be bound to the particle. Further, neither reference alone or in combination discloses any preference or order of bonding a stabilizer such as described by Grunwald and a catalyst such as described by Mueller'288. Claim 12 recites such a preference, and as discussed extensively in the specification and in this amendment, the order of bonding of stabilizer and catalyst onto abrasive creates a different structure with vastly different polishing characteristics. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 12.

With further respect to dependent claim 13

Claim 13 further recites that the stabilizer be bonded to the abrasive before bonding the catalyst. This is clearly in no way taught nor suggested in any way in Grunwald'710 nor in Mueller'288, alone or in combination. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 13.

With further respect to dependent claims 13, 16, and 30

Claims 13, 16, and 30 recite that the stabilizer comprises tungstate. Tungsten is nowhere described as a suitable coating for a particle in either Grunwald'710 or Mueller'288. Grunwald nowhere suggests the stabilizer can comprise tungsten, but the Examiner opines with no supporting evidence that the disclosure of "Wo" teaches tungsten. Mueller'288 discloses a large number of catalysts including Ag, Co, Cr, Cu, Fe, Mo, Mn, Nb, Ni, Os, Pd, Ru, Sn, Ti, and V at column 5 lines 33-34. Tungsten is conspicuous only in its absence. Nevertheless, despite neither reference teaching a coating of tungsten, the Examiner opines that an abrasive comprising a catalyst and a stabilizer comprising tungsten coated thereon is obvious over the combination of these references. Then the Examiner opines that tungstate would be an obvious choice using the same language reproduced in the previous rejection above, which apparently can be summarized as saying that tungstate would be obvious because it is insoluble, and the reference calls for an insoluble metal compound. The Examiners attention is directed to paragraph [0068] of the

instant specification which teaches dissolving 10.9 grams of sodium tungstate into less than a liter of water. As the Examiner has not established a *prima facie* case of unpatentability, Applicants respectfully request the Examiner reconsider this rejection with respect to claims 13, 16, and 30.

Rejection over Mueller '288 in view of Small '398

The Examiner has rejected claims 1-16, 27, 30, and 32-34 as obvious over Mueller'288 in view of Small'398. Applicant traverses.

With respect to independent claim 1 and dependent claims 2-11

Independent claim 1 recites “at least one stabilizer comprising B, Al, or mixtures thereof.” The Examiner states in pertinent part that “the references teach all but Al, B, and W, however, the reference clearly states that the at least one catalyst is a metal that has multiple oxidation states and is not limited to the ones defined.” Regardless of whether the references do teach what the Examiner says they teach, they still do not teach the limitation of claim 1.

While not quoted by the Examiner, Mueller '288 states “The catalyst or catalysts chosen may be metallic, non-metallic, or a combination thereof and the catalyst must be able to shuffle electrons efficiently and rapidly between the oxidizer and metal substrate surface.” Given the Examiner’s expansive reading of other art, an argument might be made that Mueller ‘288 by saying “metallic, non-metallic, or a combination thereof” discloses every element and combination of elements in existence. Mueller gives no characteristics, properties, nor identities of any non-metallic catalyst, except to say “the catalyst must be able to shuffle electrons efficiently and rapidly between the oxidizer and metal substrate surface.” Indeed, to shuffle electrons efficiently the catalyst of Mueller ‘288 must both have multiple oxidation states AND must be soluble, so as to substantially contact the substrate.

But neither boron nor aluminum have multiple oxidation states, and therefore some hypothetical catalyst made from boron or aluminum could not “shuffle electrons” as the term is used in Mueller '288. To shuffle electrons you need multiple oxidation states, and both aluminum and boron each has only a single oxidation state which is +3. Applicants have attached herewith printed out websites which show this fact. Further, any stabilizer even if it could shuffle electrons could not do so “efficiently and rapidly between the oxidizer and metal

substrate surface" as this requires that the catalyst be soluble. As the references do not alone or in combination teach or suggest a coating of a stabilizer comprising either Al or B, Applicants respectfully request the Examiner reconsider this rejection with respect to claim 1.

With respect to independent claim 12 and dependent claims 13-15 and 32-34

Claims 12-15 and 32-34 not only recite that the particle comprise a stabilizer and a catalyst, but also that the stabilizer is bonded to the abrasive prior to or simultaneously with the bonding the catalyst to the abrasive. No stabilizer is taught nor disclosed in Small'398, and Small'398 does not disclose any preference or order of bonding catalysts to an abrasive. Mueller similarly does not teach any stabilizer, nor a preference as to bonding a stabilizer onto an abrasive before or at the same time as a catalyst, nor even any preference as to the order of bonding catalysts to the abrasive. Claim 12 recites such a preference which is not taught or suggested in either reference alone or in combination.

The Examiner states that this limitation "is defining a process limitation (how it is bonded) and as is well known process limitations used to define a product in a product by process claims do not patentably distinguish the product even though made by a different process. Applicants disagree. The specification and the examples clearly show the product made by bonding the stabilizer first and the catalyst second is not equivalent to the product made by bonding the catalyst first and the stabilizer second. There are numerous reasons. If stabilizer is bound second, a portion of the catalyst will be obscured by the stabilizer. But more importantly, the catalyst is made more effective because the catalyst actually bonds not to the abrasive but to the stabilizer itself. (This is clear from the examples, where substantially all available sights were coated by stabilizer boric acid, and then the catalyst was added.) This added efficacy of catalyst bonded to stabilizer compared to catalyst bonded to silica makes thermodynamic sense, because a boron-Fe bond is shorter than a Silica-Fe bond and therefore has higher energy. All rational reasons, but none are mentioned in the specification. Applicant is bound by the specification, which merely states and demonstrates that abrasives made the claimed way are superior to, and therefore different than, abrasives made in the alternative way. Applicants respectfully request the Examiner reconsider this rejection with respect to claim 12.

Claims 13, 32 and 34 further recite that the stabilizer be bonded to the abrasive before bonding the catalyst. This is clearly in no way taught nor suggested in any way in either Mueller

nor Small'398. Applicants respectfully request the Examiner reconsider this rejection with respect to claims 13, 32, and 34.

With further respect to dependent claims 4, 6-10, 13-15, and 32-33

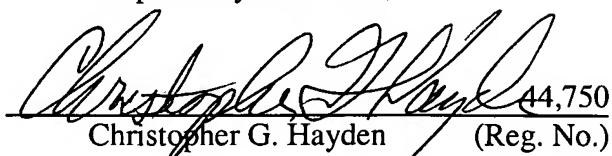
Claim 4, 6-10, 13-15, and 32-33 recites the stabilizer comprises B. Neither Mueller '288 nor Small '398 alone or in combination suggest any boron-containing coating. While Mueller '288 says a catalyst can be "non-metallic," this does not form a *prima facie* case as boron is not a catalyst. Applicants respectfully request the Examiner reconsider this rejection with respect to claims 4, 6-10, 13-15, and 32-33.

With further respect to claims 13, 16, and 30

Claims 13, 16, and 30 recite that the stabilizer comprises tungstate. Tungsten is nowhere described as a suitable coating for a particle in either Small'398 or Mueller'288. Tungstate, recited in claims 13, 16, and 30, is nowhere described in either Small'398 or Mueller'288. Applicants respectfully request the Examiner reconsider this rejection with respect to claims 13, 16, and 30.

A sheet authorizing the required fees for amending claims 28 and 29 to be in independent form is attached hereto. No additional fee is believed necessary relating to this response – however, if any additional fees are deemed necessary for any reason, the Office is authorized to charge them to Morgan, Lewis & Bockius LLP Deposit Account No. 50-0310.

Respectfully submitted,


Christopher G. Hayden 44,750
(Reg. No.)

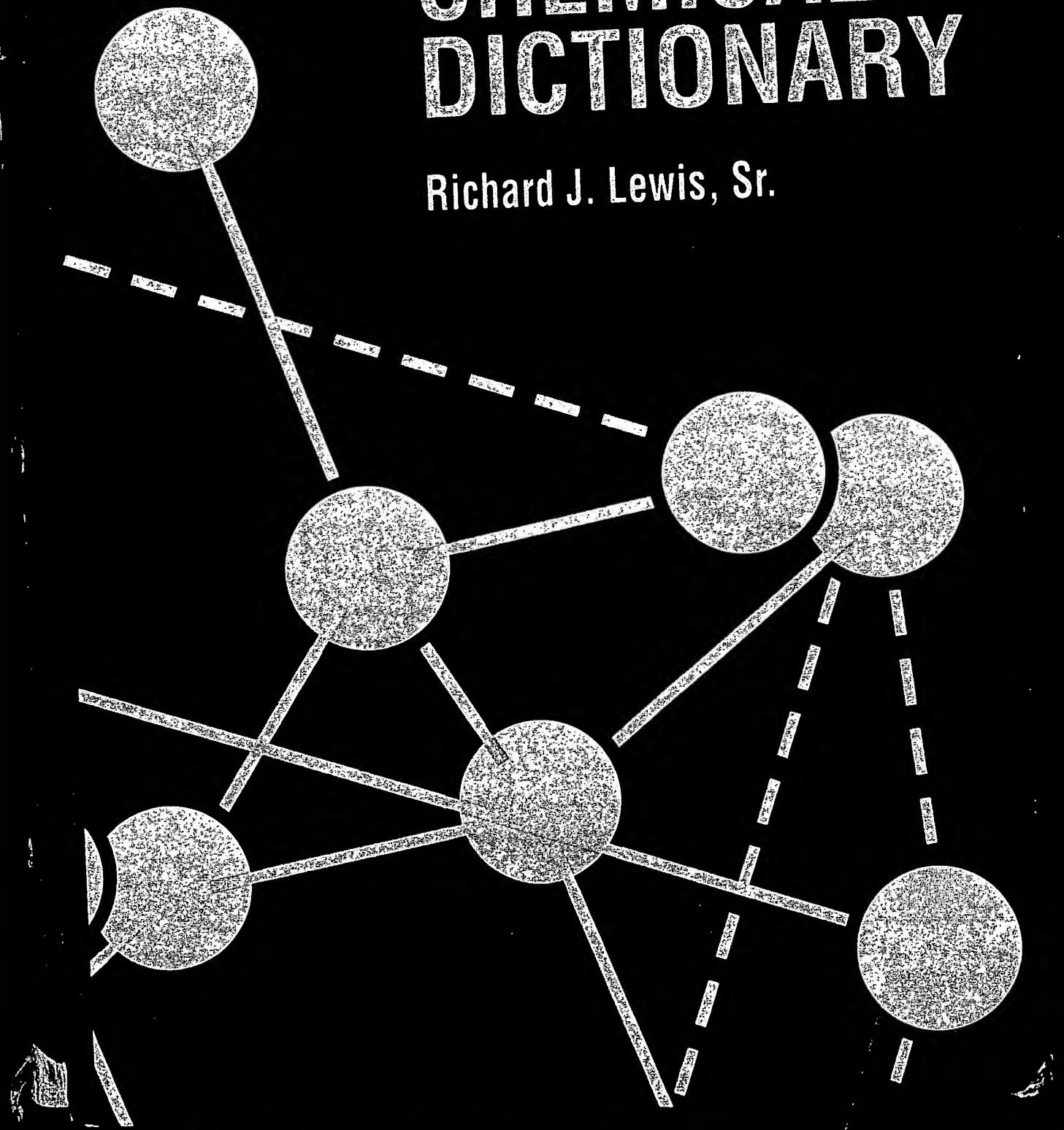
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BORON ALLOY

to 3000C; Mohs hardness from 8 to 10; thermally and electrically conductive; high chemical stability; do not react with hydrochloric or hydrofluoric acids but are attacked by hot alkali hydroxides; color varies from gray (transition-metal) to black (alkaline-earth) to blue (rare-earth).

Derivation: (1) Sintering mixtures of metal powder and boron at 2000C; (2) reduction of mixture of the metal oxide and boric oxide with aluminum, silicon, or carbon; (3) fused-salt electrolysis; (4) vapor-phase deposition.

Use: High-temperature service as rocket nozzles, turbines, etc.

borneol. (bornyl alcohol; 2-camphanol; 2-hydroxycamphane). CAS: 507-70-0.

$C_{10}H_{17}OH$.

Properties: White, translucent lumps; sharp, camphor-like odor; burning taste; soluble in alcohol and ether; insoluble in water. Optically active in natural form, racemic form made synthetically. D 1.011, mp 208C, bp 212C. Flammable.

Derivation: Natural form from a species of tree in Borneo and Sumatra. Synthesized from camphor by hydrogen reduction or from α -pinene.

Grade: Technical.

Hazard: Fire risk in presence of open flame.

Use: Perfumery, esters.

Born equation. An equation representing the free energy of solvation of an ion.

bornyl acetate. $C_{10}H_{17}OOCCH_3$.

Properties: Colorless liquid, solidifying to crystals at approximately 50F; piny-camphoraceous odor. Soluble in 3 volumes of 70% alcohol, miscible with 95% alcohol and with ether, d 0.980-0.984, refr index 1.463-1.465, mp 29C. Combustible.

Derivation: Interaction of borneol and acetic anhydride in the presence of formic acid.

Grade: Technical, FCC.

Use: Perfumery, flavoring, nitrocellulose solvent.

bornyl alcohol. See borneol.

bornyl formate. $C_{10}H_{17}OOCH$.

Properties: Colorless liquid having a piny odor, d 1.007-1.009. Combustible.

Grade: Technical.

Use: Perfuming of soaps, disinfectants, and sanitary products; flavoring.

bornyl isovalerate. $C_{10}H_{17}OOC_2H_5$. A constituent of valeren oil.

Properties: Limpid fluid; aromatic, valeren-like odor. Soluble in alcohol and ether, insoluble in

water, d 0.951 (20C), bp 255-260C. Combustible.

Use: Medicine, essential-oil intermediate, flavoring.

boroethane. See diborane.

boron. B. Nonmetallic element of atomic number 5, group IIIA of the periodic table. Atomic weight 10.81. Valence 3. Two stable isotopes: 11 (approximately 81%) and 10 (approximately 19%).

Properties: Black, hard solid; brown, amorphous powder; crystals. Highly reactive. Soluble in concentrated nitric and sulfuric acids; insoluble in water, alcohol, and ether. High neutron absorption capacity. Amphoteric. A plant micronutrient. D 2.45, mp 2300C. Mohs hardness 9.3. Sources: Borax, kernite, colemanite, ulexite.

Derivation: (1) By heating boric oxide with powdered magnesium or aluminum; (2) by vapor-phase reduction of boron trichloride with hydrogen over hot filaments (80-2000C); (3) by electrolysis of fused salts.

Forms: Filament, powder, whiskers, single crystals.

Grade: Technical (90-92%), 99% pure, high-purity crystals.

Hazard: Dust ignites spontaneously in air; severe fire and explosion hazard. Reacts exothermally with metals above 900C; explodes with hydrogen iodide.

Use: Special-purpose alloys, cementation of iron, neutron absorber in reactor controls; oxygen scavenger for copper and other metals, fibers and filaments in composites with metals or ceramics, semiconductors, boron-coated tungsten wires, rocket propellant mixtures, high-temperature brazing alloys.

See also boron alloy, boron fiber, boron-10.

boron-10. Nonradioactive isotope of boron of mass number 10.

Properties: Has marked capacity for absorbing slow neutrons, emitting a high-energy α -particle in the process.

Derivation: Constitutes approximately 19% of natural boron.

Forms available: Crystalline powder, dry amorphous powder, colloidal suspension of dry amorphous powder in oil; in boron trifluoride-calcium fluoride, in potassium borofluoride, in boron trifluoride ethyl etherate, in boric acid.

Use: Neutron counter, radiation shielding (in the form of boral), medicine.

boron alloy. A uniformly dispersed mixture of boron with another metal or metals. Ferroboron usually contains 15-25% boron, manganese boron usually 60-65% manganese.

Use: Degasifying and deoxidizing agents, to

11.

The

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boride

bossa nova

as an antiseptic and a preservative and in detergents.
bo·ride (bōr'īd, bōr'ē) *n.* A binary compound of boron with a more electropositive element or radical.

bo·ring (bōr'īng, bōr'ē) *adj.* Not interesting; tiresome; dull.

bo·ring·ly *adv.* —bo·ring·ness *n.*

SYNONYMS *boring, monotonous, tedious, irksome, tiresome, humdrum.* These adjectives refer to what is so uninteresting as to cause mental weariness. *Boring* implies feelings of listlessness and discontent: *a boring book*. *What is monotonous* bores because of lack of variety: *a monotonous day*. *Tedious* suggests dull slowness or long-windedness: *spent tedious hours on the train*. *Irksome* describes what is demanding of time and effort and yet is dull and often uninteresting: *"I know and feel what an irksome task the writing of long letters is."* (Edmund Burke). *Something tiresome* fatigues because it seems to be interminable or marked by unremitting sameness: *"What a tiresome being is a man who is fond of talking."* (Benjamin Jowett). *Humdrum* refers to what is commonplace, trivial, or unexcitingly routine: *led a humdrum existence*.

Bor·laug (bōrlōg'), Norman Ernest b. 1914. Amer. agronomist who won the 1970 Nobel Peace Prize for his attempts to overcome world hunger through advances in agriculture.

Bor·mann (bōr'mān'), Martin Ludwig 1900-45. German Nazi official who served as Hitler's secretary (1941-45).

born (bōrn) *v.* A past participle of bear¹. *adj.* 1a. Brought into life by birth. b. Brought into existence; created. 2a. Having from birth a particular quality or talent: *a born artist*. b. Destined, or seemingly destined, from birth. 3. Resulting or arising. 4. Native to a particular place. Often used in combination: *Irish-born*.

—born² *adj.* *born yesterday* Naive or ignorant. Used in negative constructions: *Of course I can use a computer; I wasn't born yesterday*.

Born, Max 1882-1970. German-born physicist who shared a 1954 Nobel Prize.

born··gain (bōrn'-gān') *adj.* 1a. Of, relating to, or being one

who has converted to or renewed faith in Christianity. b. Of or relating to evangelical Christianity. 2. Characterized by fervent renewal, resurgence, or return. [From *born again* in John 3:3 and 7.]

born··born (bōrn' bōrn) *v.* A past participle of bear¹.

Borneo¹ (bōrn'ēō') *n.* An island of the W Pacific Ocean in the Malay Archipelago between the Sulu and Java seas SW of the Philippines. The sultanate of Brunei is on the NW coast; the rest of the island is divided between Indonesia and Malaysia.

—Bornean *adj.* & *n.*

Born··holm (bōrn' hōlm', -hōm') An island of E Denmark in the Baltic Sea near Sweden.

Born··ite (bōrn'īt') *n.* A brownish-bronze, lustrous copper ore, Cu₁₂Fe₂, that tarnishes to purple when exposed to air. [After Ignaz von Born (1742-91), Austrian mineralogist.]

Bor·nu (bōrnōō) *n.* A region and former Muslim kingdom of W Africa that became part of Nigeria in 1902.

bor··o·bor··pref. Boron: borosilicate. [From BORON.]

Bor·ro·bi·dur (bōr'ō-bō-dōōr', bōr') *n.* A ruined Buddhist shrine in central Java; dating probably from the 9th cent.

Bor·ro·din (bōr'ō-dēn', bār', bā-rō-dēn'), Aleksandr Porfir'yich 1833-97. Russian composer whose works are based on folk themes.

Bor·ro·di·no (bōr'ō-dē-nō, bōr', -bā-rā-dē-yē-nō') *n.* A village of W Russia W of Moscow. Nearby, Napoleon defeated the Russian troops defending Moscow in 1812.

Bor·ro·n (bōr'ō-n, bōr') *n.* Symbol B A soft, amorphous or crystalline nonmetallic element used in flares and nuclear reactor control rods. Atomic number 5; atomic weight 10.811; melting point 2,300°C; sublimation point 2,550°C; specific gravity (crystal) 1.24; valence 3. See table at element. [From BOR(A) + CARBON.] *—bor··on·ic (bā-rō-nīk, bō-) adj.*

bor··on carbide *n.* A compound of boron and carbon, esp. B₄C, an extremely hard crystalline compound used as an abrasive and neutron absorber.

bor··o·sil··icate (bōr'ō-sil'ī-kāt, -kāt', bōr', bōr') *n.* A salt that is derived from both boric acid and silicic acid and occurs usually in diumontite.

bor··o·silicate glass *n.* A strong heat-resistant glass that contains a minimum of 5 percent boric oxide.

bor··ough (bōr'ō, bōr'ō) *n.* 1. A self-governing incorporated town in some US states. 2. One of the five administrative units of New York City. 3. A civil division of Alaska that is the equivalent of a county in most other US states. 4. Chiefly British a. A town having a municipal corporation and certain rights. b. A town that is representative to Parliament. 5. A medieval group of fortified houses that formed a town with special privileges and franchises. [ME *burg*, city; < OE *burg*, fortified town. See bhergh-.]

bor··ough Eng··ish (bōr'ō-īng'ish, bōr'ē) *n.* An old custom in certain English boroughs whereby the right to inherit an estate went to the youngest son or, in default of male issue, to the youngest brother. [Partial transl. of AN *tenure en burgh* Enheritance in an English borough. See BOROUGH.]

bor··o·le (bōr'ō-lē, bōr'ē-lē) *n.* Any of various irregularly

coiled helical spirochetes of the genus *Borrelia*, some of which cause relapsing fever. [NLat., after Amédée *Borrel* (1867-1936), French bacteriologist.]

bor··row (bōr'ō, bōr'ō) *v.* -rowed, -row·ing, -rows *—tr.* 1. To obtain or receive (something) on loan with the promise or understanding of returning it or its equivalent. 2. To adopt or use as one's own. 3. In subtraction, to take a unit from the next larger denomination in the minuend so as to make a number larger than the number to be subtracted. *—intr.* 1. To obtain or receive something. 2. Linguistics To adopt words from one language for use in another. *—idom:* borrow trouble To take an unnecessary action that will probably have adverse effects. [ME *borwen* < OE *borgian*.] *—bor·row·er n.*

bor··rowed time (bōr'ōd, bōr'ē) *n.* A period of uncertainty during which the inevitable consequences of a current situation are postponed or avoided.

bor··row·ing (bōr'ō-ing, bōr'ē) *n.* Something that is borrowed, esp. a word borrowed from one language to another.

bortsch also bortsht (bōrsh̄) or borsch (bōrsh̄) *n.* A beet soup usu. served with sour cream. [Yiddish *bortsht* < Russ. *bortsch*, cow parsnip (the original soup base), *bortsht*.]

bortsch belt or Bortsht Belt *n.* Informal The predominantly Jewish hotels of the Catskill Mountains, known for their vaudeville-type entertainment. [From the popularity of bortscht in the cuisine.]

bort (bōrt) *n.* 1. Poorly crystallized diamonds used for industrial cutting and abrasion. 2. A carbonado. [Prob. < Du. *boort*.] *—borty adj.*

bort·zol (bōr'zōl') *n.*, pl. -zols Any of a breed of tall slender dogs with a narrow pointed head and a silky coat, originally developed in Russia for hunting wolves. [From Russ. *borzoi*, swift, var. of *borzyl*.]

Bosc (bōsk) *n.* A variety of pear with greenish-yellow skin overlaid with reddish-brown and juicy sweet flesh. [After Louis Auguste Guillaume Bosc (1759-1828), Belgian horticulturist.]

bos··age also bos··kage (bōs'kāj) *n.* A mass of trees or shrubs; a thicket. [ME *bosage* < OFr. *bosage* < *bosc*, forest, of Gmc. orig.]

Bosch (bōsh, bōsh̄, bōs) Hieronymus 1450?-1516. Dutch painter whose largely religious works are characterized by grotesque, fantastic creatures mingling with human figures.

Bose (bōs), Satyendra Nath 1894-1974. Indian physicist noted for his work in quantum mechanics.

Bose-Ein·stein condensate (bōs'ēn'stēn') *n.* A state of matter that forms below a critical temperature in which all bosons that comprise the matter fall into the same quantum state. [After Satyendra Nath Bose and Albert EINSTEIN.]

bosh (bōsh) Informal n. Nonsense. *—intj.* Used to express disbelief or annoyance. [From Turk. *bos*, empty.]

bosk (bōsk) *n.* A small wooded area. [Back-formation < BOSKY.]

bosk·y (bōs'kē) *adj.* *i-er, i-est* 1. Having many bushes, shrubs, or trees. 2. Of or relating to woods. [From ME *bosk*, bush < Med.Lat. *bosca*, of Gmc. orig.] *—bosk·i·ness n.*

bo's·n or bo's·n (bōs'ān) *n.* Variants of boatswain.

Bos··ni·a (bōz'ē-nē-ā) *n.* 1. A region constituting the N section of Bosnia and Herzegovina; settled by Serbs in the 7th cent. 2. See Bosnia and Herzegovina. *—Bos··ni·an adj. & n.*

Bosnia and Herz··go··vi·na (hēr'ē-sā-gō-vē-nā, -gō-vā-, hūrē-) also Bosnia-Herzegovina Commonly known as Bosnia. A country of the NW Balkan Peninsula W of Serbia; a constituent republic of Yugoslavia from 1946 to 1991. Cap. Sarajevo. Pop. 3,527,000.

bos··om (bōz'ōm, bōz'ām) *n.* 1a. The chest of a human. b. A woman's breast or breasts. 2. The part of a garment covering the chest or breasts. 3. Security and closeness likened to being held in a warm familial embrace. 4. The chest considered as the source of emotion. *—adj.* Beloved; intimate. [ME < OE *bōsm*.]

bo··son (bōs'ōn) *n.* Any of a class of particles that have zero or integral spin and obey statistical rules permitting any number of identical particles to occupy the same quantum state. [After Satyendra Nath Bose.]

Bos··po··rus (bōs'pōr-əs) A narrow strait separating European and Asian Turkey and joining the Black Sea with the Sea of Marmara; an important trade route since ancient times.

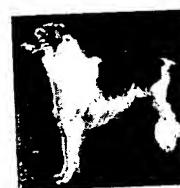
bos··que (bōs'kēt) *n.* A small grove; a thicket. [Fr. < Ital. *boschetto*, dim. of *bosco*, forest, of Gmc. orig.]

boss¹ (bōs, bōs) *n.* 1a. An employer or a supervisor. b. One who makes decisions or exercises authority. 2. A politician who controls a party or a political machine. *—v.* bossed, boss·ing, bosses² *—tr.* 1. To supervise or control. 2. To give orders to, esp. arrogantly or domineeringly. *—intr.* To be or act as a supervisor or controlling element. *—adj. Slang* First-rate; top-notch. [Du. *baas*, master.]

boss² (bōs, bōs) *n.* 1. A circular protuberance or knoblike swelling, as on animal horns. 2. A raised area used as ornamentation. 3. *Architecture* A raised ornament. 4a. An enlarged part of a shaft to which another shaft is coupled or to which a wheel or gear is keyed. b. A hub, esp. of a propeller. *—tr.v.* bossed, boss·ing, bosses³ *n.* To emboss. [ME *bocē* < OFr.]

boss³ (bōs, bōs) *n.* A cow or calf. [Perh. ult. < Lat. *bōs*. See BOVINE.]

bos··sa no··va (bōs'ā nō'vā, bōs'ā) *n.* 1. A style of popular Bra-



borzoi



Bosnia and Herzegovina

boss²

ā	pat	oi	boy
ā	pay	ou	out
ār	care	ōō	took
ā	father	ōō	boot
ē	pet	ū	cut
ē	be	ū	urge
i	pit	th	thin
i	pie	th	this
ir	pier	hw	which
ō	pot	zh	vision
ō	toe	ā	abou
ō	paw	item	

Stress marks:

' (primary);

' (secondary), as in

lexicon (lēk'sī-kōn)

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Science Education



It's Elemental

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13

Al

Aluminum

26.981538

Aluminum

Atomic Number: 13**Atomic Weight:** 26.981538**Melting Point:** 933.437 K (660.323°C or 1220.581°F)**Boiling Point:** 2792 K (2519°C or 4566°F)**Density:** 2.70 grams per cubic centimeter**Phase at Room Temperature:** Solid**Element Classification:** Metal**Period Number:** 3 **Group Number:** 13 **Group Name:** none**What's in a name?** From the Latin word for alum, **alumen**.**Say what?** Aluminum is pronounced as **ah-LOO-men-em**.**History and Uses:**

Although aluminum is the most abundant metal in the earth's crust, it is never found free in nature. All of the earth's aluminum has combined with other elements to form compounds. Two of the most common compounds are alum, such as potassium aluminum sulfate ($KAl(SO_4)_2 \cdot 12H_2O$), and aluminum oxide (Al_2O_3). About 8.2% of the earth's crust is composed of aluminum.

Scientists suspected that an unknown metal existed in alum as early as 1787, but they did not have a way to extract it until 1825. Hans Christian Oersted, a Danish chemist, was the first to produce tiny amounts of aluminum. Two years later, Friedrich Wöhler, a German chemist, developed a different way to obtain aluminum. By 1845, he was able to produce samples large enough to determine some of aluminum's basic properties. Wöhler's method was improved in 1854 by Henri Étienne Sainte-Claire Deville, a French chemist. Deville's process allowed for the commercial production of aluminum. As a result, the price of aluminum dropped from around \$1200 per kilogram in 1852 to around \$40 per kilogram in 1859. Unfortunately, aluminum remained too expensive to be widely used.

Two important developments in the 1880s greatly increased the availability of aluminum. The first was the invention of a new process for obtaining aluminum from aluminum oxide. Charles Martin Hall, an American chemist, and Paul L. T. Héroult, a French chemist, each invented this process independently in 1886. The second was the invention of a new process that could cheaply obtain aluminum oxide from bauxite. Bauxite is an ore that contains a large amount of aluminum hydroxide ($Al_2O_3 \cdot 3H_2O$), along with other compounds. Karl Joseph Bayer, an Austrian chemist, developed this process in 1888. The Hall-Héroult and Bayer processes are still used today to produce nearly all of the world's aluminum.

With an easy way to extract aluminum from aluminum oxide and an easy way to extract large amounts of aluminum oxide from bauxite, the era of inexpensive aluminum had begun. In 1888, Hall formed the Pittsburgh Reduction Company, which is now known as the Aluminum Company of America, or Alcoa. When it opened, his company could produce about 25 kilograms of aluminum a day. By 1909, his company

was producing about 41,000 kilograms of aluminum a day. As a result of this huge increase of supply, the price of aluminum fell rapidly to about \$0.60 per kilogram.

Today, aluminum and aluminum alloys are used in a wide variety of products: cans, foils and kitchen utensils, as well as parts of airplanes, rockets and other items that require a strong, light material. Although it doesn't conduct electricity as well as copper, it is used in electrical transmission lines because of its light weight. It can be deposited on the surface of glass to make mirrors, where a thin layer of aluminum oxide quickly forms that acts as a protective coating. Aluminum oxide is also used to make synthetic rubies and sapphires for lasers.

Estimated Crustal Abundance: 8.23×10^4 milligrams per kilogram

Estimated Oceanic Abundance: 2×10^{-3} milligrams per liter

Number of Stable Isotopes: 1 ([View all isotope data](#))

Ionization Energy: 5.986 eV

Oxidation State: +3

Electron Shell Configuration: $1s^2$
 $2s^2$ $2p^6$
 $3s^2$ $3p^1$

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Science Education



It's Elemental

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5

B

Boron

10.811

Boron

Atomic Number: 5**Atomic Weight:** 10.811**Melting Point:** 2348 K (2075°C or 3767°F)**Boiling Point:** 4273 K (4000°C or 7232°F)**Density:** 2.37 grams per cubic centimeter**Phase at Room Temperature:** Solid**Element Classification:** Semi-metal**Period Number:** 2 **Group Number:** 13 **Group Name:** none

What's in a name? From the Arabic word **Buraq** and the Persian word **Burah**, which are both words for the material "borax."

Say what? Boron is pronounced as **BO-ron**.

History and Uses:

Boron was discovered by Joseph-Louis Gay-Lussac and Louis-Jaques Thénard, French chemists, and independently by Sir Humphry Davy, an English chemist, in 1808. They all isolated boron by combing boric acid (H_3BO_3) with potassium. Today, boron is obtained by heating borax ($Na_2B_4O_7 \cdot 10H_2O$) with carbon, although other methods are used if high-purity boron is required.

Boron is used in pyrotechnics and flares to produce a green color. Boron has also been used in some rockets as an ignition source. Boron-10, one of the naturally occurring isotopes of boron, is a good absorber of neutrons and is used in the control rods of nuclear reactors, as a radiation shield and as a neutron detector. Boron filaments are used in the aerospace industry because of their high-strength and lightweight.

Boron forms several commercially important compounds. The most important boron compound is sodium borate pentahydrate ($Na_2B_4O_7 \cdot 5H_2O$). Large amounts of this compound are used in the manufacture of fiberglass insulation and sodium perborate bleach. The second most important compound is boric acid (H_3BO_3), which is used to manufacture textile fiberglass and is used in cellulose insulation as a flame retardant. Sodium borate decahydrate ($Na_2B_4O_7 \cdot 10H_2O$), better known as borax, is the third most important boron compound. Borax is used in laundry products and as a mild antiseptic. Borax is also a key ingredient in a substance known as Oobleck, a strange material 6th grade students experiment with while participating in Jefferson Lab's BEAMS program. Other boron compounds are used to make borosilicate glasses, enamels for covering steel and as a potential medicine for treating arthritis.

Estimated Crustal Abundance: 1.0×10^1 milligrams per kilogram

Estimated Oceanic Abundance: 4.44 milligrams per liter

Number of Stable Isotopes: 2 ([View all isotope data](#))

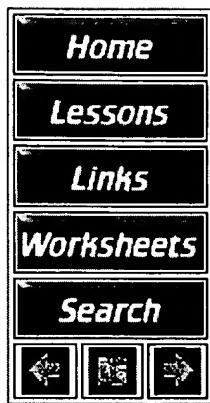
Ionization Energy: 8.298 eV

Oxidation State: +3

Electron Shell Configuration: $1s^2$
 $2s^2$ $2p^1$

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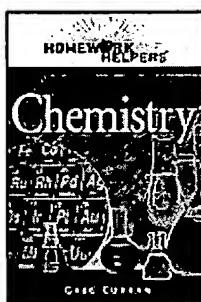


Science Help Online Chemistry

Lesson 5-2

Oxidation Numbers

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The chemical formula for water is H_2O . Carbon Dioxide is CO_2 .

Why does oxygen combine in different ratios, in different compounds? Do Chemistry students need to memorize the chemical formulas for each of the millions of known compounds? Is there a way to predict the ratio by which elements will combine in a given situation? Fortunately, that is what **oxidation numbers** are for.

You probably recall learning about **ions** in Biology. An **ion** is a charged particle formed when a neutral atom or group of atoms gain or lose one or more electrons. When a single atom forms an ion, as in the case of Al^{+3} , it is called a **monatomic ion**. When a group of atoms that are covalently bonded together form an ion, as in the case of NH_4^+ , it is called a **polyatomic ion**.

Sometimes ions with opposite charges are attracted together and will form **ionic compounds**. Table Salt, $NaCl$ is such a compound formed from Na^+ ions and Cl^- ions. Neutral atoms can also form compounds when they join together, as in the case of water (H_2O). However, since these compounds are not composed of ions, they are called **molecular compounds**. You will learn more about these types of compounds in lesson 5-3.

Regardless as to whether a compound is made up of ions or not, each atom in the compound has an apparent charge. This apparent charge, called the **oxidation number**, represents the charge that an atom would have if electrons were transferred completely to the atom with the greater attraction for them in a given situation. These oxidation numbers can be used to predict the ratio by which atoms will combine when they form compounds.

The following rules help us assign the oxidation number of elements:

Table 5-2a - Predicting Oxidation Numbers

1. In free elements (that is, in uncombined state), each atom has an

oxidation number of zero. Ex. In O₂, the oxidation number of each oxygen atom is zero.

2. For ions composed of only one atom, the oxidation number is equal to the charge on the ion. Ex. The oxidation number of Ca²⁺ is +2.

3. All alkali metals (elements in column 1 of the periodic table, with the exception of hydrogen) have an oxidation number of +1. Ex. The oxidation numbers of Li, K, and Na will always be +1.

4. All alkaline earth metals (elements in column 2 of the periodic table) have an oxidation number of +2. Ex. The oxidation number of Ba is +2.

5. The oxidation number of Aluminum (Al) is always +3.

6. The oxidation number of oxygen in most compounds (such as H₂O and CO₂) is -2. In hydrogen peroxide (H₂O₂) and peroxide (O₂²⁻) oxygen shows a -1 oxidation number.

7. The oxidation number of hydrogen is +1, except when it is bonded to a metal as a negative ion, in which case it is -1. Ex. H₂O shows hydrogen as +1. NaH shows hydrogen as -1.

8. When halogens (elements in column 17 on the periodic table) form negative ions, they will have an oxidation number of -1. Ex. NaCl and CaCl₂ both show chlorine with a -1 oxidation number.

9. In a neutral molecule, the sum of the oxidation numbers of all of the atoms must be zero. Ex. In H₂O, each hydrogen is +1 and the oxygen is -2. So, (2 x +1) + (-2) = 0.

10. In a polyatomic ion, the sum of oxidation numbers of all the elements in the ion must be equal to the net charge of the ion. Ex. In the polyatomic ion known as hydroxide (OH⁻), the oxygen is -2 and the hydrogen is +1. So, (-2) + (+1) = -1, the same as the charge on the hydroxide ion (OH⁻)

Now, in time you will find it easy to predict many oxidation numbers, as you become more familiar with the periodic table and the rules above. Until that time, you should make use of reference tables that list the oxidation numbers of common ions. Depending on your teacher, he or she may allow you to make use of such tables for quizzes and exams. For your convenience, I will provide examples of these tables below. Keep in mind that the table that your teacher uses may differ from the ones provided below.

Table 5-2b - Oxidation Numbers of Some Common Monatomic Ions						
	CHARGE					

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